

9 November 1960

~~SUPERSEDING~~

MIL-P-19419(NOrd)

22 June 1956

MILITARY SPECIFICATION

PLATING, CHROMIUM, ELECTRO-DEPOSITED,
(ON THE INTERIOR SURFACES OF
20 MM MARK 11 GUN BARRELS)

This specification has been approved by the
Bureau of Naval Weapons, Department of the Navy.

1. SCOPE

1.1 This specification presents detailed requirements for high contraction electrodeposited chromium plating on the bores, grooves, and chambers of 20mm Mark 11 Gun Barrels.

1.2 The requirements apply to 20mm Mark 11 Gun Barrels whose interior surfaces have not been nitrided prior to plating.

2. APPLICABLE DOCUMENTS

2.1 The following specifications, standards, and publications of the issue in effect on the date of invitation for bids, form a part of this specification.

SPECIFICATIONS

MILITARY

MIL-L-3150 - Lubricating oil, preservative medium.
MIL-C-16173 - Corrosion Preventive, Solvent Cutback,
Cold Application

STANDARDS

FEDERAL

FED-STD-151 - Metals; Test Methods

FSC 1005

MILITARY

- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-129 - Marking for Shipment and Storage.

PUBLICATIONS

BUREAU OF NAVAL WEAPONS

- OP 400 - General Instructions for the Design, Manufacture, and Inspection of Naval Ordnance Equipment.
- OP 1105 - Preservation and Preservation Maintenance of Ordnance Equipment in Shore Storage.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Equipment. - Equipment for performing the chromium plating operations shall be furnished by the contractor subject to the approval of the procuring activity.

3.2 Material. -

3.2.1 Basic material. - The basic material of the 20mm Mark 11 Gun Barrel shall be of a quality, composition, and having the physical properties in accordance with the detail specifications for the part. Plating with chromium shall be considered to affect only the surface properties of the interior of the barrel (i. e., hardness, resistance to wear, erosion, corrosion, and coefficient of friction).

3.2.1.1 Surface finish. - All interior surfaces of the barrel shall be substantially free from tool marks, cracks, pits, gouges, flakes, slivers, corrosion, or any other surface defects that would affect the application or the performance of the chromium plate. The surface roughness of the interior surfaces prior to plating shall conform to the applicable drawing requirements for surface roughness after plating.

3.2.1.2 Protection after machining. - After the final machining operation, both the interior and exterior surfaces of the barrel shall be cleaned to insure removal of all cutting oil and other foreign matter. Immediately following inspection, these surfaces shall be coated with Lubricating Oil, Preservative, Medium, Specification MIL-L-3150, for the protection of all surfaces until the barrels are chromium plated.

3.3 Interior dimensions of the gun barrel before plating and before electropolishing. -

3.3.1 Removal of metal. - The required interior dimensions of the gun barrel before plating shall be obtained by electropolishing, by mechanical removal of metal, or by a combination of mechanical removal of metal and electropolishing as specified in the applicable drawings.

3.3.2 Before plating. - The interior dimensions of the gun barrels before chromium plating shall be such that the barrel dimensions will conform to the drawing dimensions within the prescribed tolerances after plating with the required thickness of chromium plate.

3.3.3 Before electropolishing. - The interior dimensions of the gun barrel before electropolishing and chromium plating shall be such that the barrel dimensions will conform to the drawing dimensions within the prescribed tolerances, after removal of the specified amount of metal by electropolishing and plating with the required thickness of chromium plate.

3.4 Chromium deposit. -

3.4.1 Thickness of deposit. - The thickness of the chromium deposit on the top of the lands, and in the chamber shall be as specified in the applicable drawings.

3.4.2 Appearance of the deposit after plating. - The chromium deposit as plated shall be smooth and homogeneous. The deposit shall be bright on the tops of the lands but a somewhat dull or slightly milky deposit in the grooves shall not be cause for rejection. "Burnt" and "frosty" deposits are unacceptable. The deposit shall be free from visible defects, such as unplated areas, blisters, flaking, trees, cracks, pits, and gouges, in accordance with the acceptance standard of this specification (see appendix).

3.5 Interior dimensions of the gun barrel after plating. The interior dimensions of the bore, grooves, and chamber after plating shall conform to drawing dimensions within the prescribed tolerances.

3.5.1 Mechanical sizing. - Mechanical honing or similar operations shall not be performed on the tops of the lands to bring the dimensions of an undersize bore within drawing dimensions, since such operations produce sharp edges at the corners of the lands which are easily broken by the honing operation itself or by subsequent firing. Mechanical honing or similar operations are permitted in the chamber (where no edges are present) to attain proper size dimensions.

3.6 Records. - The following data for each gun barrel covered by this specification shall be recorded and retained until after completion of proof or firing tests: dimensional measurements, results of visual examination, and operating conditions for electropolishing and plating.

3.7 Firing test requirements. -

3.7.1 Proof and functional firing. - The condition of the chromium deposit after proof firing and after functional firing shall meet the requirements of the applicable 20mm Aircraft Gun Mk 12 Specification when judged in accordance with acceptance standard of this specification (see appendix).

3.7.1.1 Life firing tests. - The performance of the chromium plated barrel during life firing tests shall conform to the requirements of the applicable 20mm Aircraft Gun Mk 12 Specifications.

4. QUALITY ASSURANCE PROVISIONS

4.1 General. - General inspection and test procedures shall be in accordance with Federal Standard FED-STD-151, Metals; Test Methods, and Publication OP 400.

4.1.1 Sampling. - Unless otherwise specified, and when applicable, the sampling plans and procedures used by the government inspector in the determination of the acceptability of products submitted by a supplier for Government inspection shall be in accordance with the provisions of MIL-STD-105.

4.1.2 Government Inspection. - The government inspector will make such inspections as are necessary to determine that all components and assemblies are in accordance with the requirements of the contract, pertinent drawings and specifications.

Unless otherwise specified, these inspections will be conducted in accordance with instructions contained in Publication OP 400.

4.1.3 Contractor's inspection. - Contractor's inspection shall be conducted in accordance with provisions of "Inspection by Contractor" as contained in Publication OP 400.

4.1.4 Inspection lot. - The inspection lot size shall be limited to a maximum of 50 gun barrels.

4.2 Inspection before electropolishing and plating. -

4.2.1 Visual inspection. - The interior surfaces of all barrels to be plated shall be illuminated and carefully inspected with suitable instruments to determine conformance with the requirements of 3.2.1.1. Barrels with surface defects that cannot be corrected shall be rejected as unsuitable for chromium plating.

4.2.2 Dimensional inspection. - Prior to electropolishing and plating, the bores and chambers of all barrels shall be stargaged for conformance to the requirements of 3.3. Barrels with dimensional defects that cannot be corrected shall be rejected as unsuitable for chromium plating.

4.3 Inspection after plating. -

4.3.1 Visual inspection of the chromium plate. - The interiors of all barrels after chromium plating shall be illuminated and carefully inspected with suitable instruments for conformance with the requirements of 3.4.2. Barrels with defects in the chromium plate shall be stripped and replated; the chamber may be mechanically sized in accordance with 3.5.1. All corrosion and stains noted after plating shall be removed from the unplated exterior surfaces of the gun barrels.

4.3.2 Unplated areas. - Suspected unplated areas which cannot be determined with certainty by visual inspection shall be tested by cleaning the areas with a solvent to remove grease and then swabbing with a solution containing 13.4 ounces per gallon of copper sulfate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) and 20 drops per gallon of sulfuric acid (95 percent). Deposits of copper indicate that the surfaces are not covered with chromium. Any copper sulfate solution remaining in the bore after the test shall be removed immediately by wiping with a wet cloth or cotton and the bore dried by wiping or by an air blast. Copper deposits shall be removed from the test areas by light buffing.

4.4 Thickness of deposit after plating. - The thickness of the chromium deposit in the bore, grooves, and chamber shall be measured by stargaging the barrels before and after plating to determine conformance with the requirements of 3.4.1.

4.4.1 Procedure. - Until it has been established that the procedures and equipment employed by the contractor consistently produce satisfactory chromium deposits of the required thickness, the inspector shall check the dimensions of the bores, grooves, and chambers of all barrels for conformance with thickness requirements. Thereafter, the inspector shall at his discretion check a sufficient percentage of the barrels to insure continuing conformance with thickness requirements.

4.5 Dimensional inspection after plating. - The interior surfaces of all barrels shall be stargaged after plating to determine conformance with the requirements of 3.5; mechanical sizing is permitted in accordance with 3.5.1. Barrels which do not meet dimensional requirements of the applicable drawings after plating shall be stripped and replated.

4.6 Inspection after proof and functional firing. - After proof firing, and after functional firing in accordance with the requirements of the applicable 20mm Aircraft Gun Mk 12 Specification, the chromium deposit shall be inspected for conformance with the requirements of 3.7.1.

4.7 Life firing tests. - Life firing tests shall be conducted according to the requirements of the applicable 20mm Aircraft Gun Mk 12 Specification.

5. PREPARATION FOR DELIVERY

5.1 Preservation. -

5.1.1 To proof and return. - The gun barrels shall be preserved by applying type P-2 preservative to outside surfaces and type P-9 to inside surfaces. Application shall be by one or more methods specified in Specification MIL-P-116.

5.1.2 Protection during storage. - The gun barrels shall be protected during storage in accordance with Publication OP 1105.

5.2 Marking. - Shipments shall be marked in accordance with Standard MIL-STD-129 and the applicable drawings.

6. NOTES

6.1 Intended use. - The chromium deposit is applied to the interior surfaces of the gun barrels for the purpose of reducing the amount of erosion, wear, corrosion and friction and for the purpose of reducing the amount and adhesion of copper, brass or other deposits from the projectile rotating bands, retained in the bore and grooves.

6.2 Typical equipment and procedures for chromium plating the interior surfaces of 20mm Mark 11 Gun Barrels. -

6.2.1 Equipment. - In general, the following types of equipment will be necessary:

6.2.1.1 Current sources. - Generators or rectifiers capable of supplying the necessary current at 6 to 12 volts. Current requirements will depend on production rate (i.e., number of barrels plated in a tank at the same time).

6.2.1.2 Tanks. -

6.2.1.2.1 Electropolishing. - Steel, lead lined, equipped with thermostatic controls for heating and cooling.

6.2.1.2.2 Chromium plating and anodic etching. - Steel, lead lined, or lined with such non-conductive coatings as Koroseal and acid brick, equipped with thermostatic controls for heating and cooling.

6.2.1.2.3 Alkaline cleaning. - Steel, unlined, equipped with heating coils.

6.2.1.2.4 Stripping. - Containing alkaline solutions for removing chromium plate. Steel, unlined.

6.2.1.2.5 For lead-tin plating of anodes. - Wood, asphalt lined, or steel, rubber lined.

6.2.1.2.6 Water rinse. - Steel, unlined, or steel, rubber lined.

6.2.1.3 Fume exhaust systems. - Fume exhaust systems equipped with exhaust fans, ducts, hoods, and stacks as required for exhausting the fumes from electropolishing, plating, etching, and stripping solutions.

6.2.1.4 Anodes, cathodes, fixtures, and electrical connections. -

6.2.1.4.1 Anodes for chromium plating. - Straight, hard rolled, copper bar, one-quarter inch in diameter, coated with 7 percent tin-lead alloy 0.015-inch thick for plating the bore of the barrel. The anode extension for plating the chamber should be shaped to insure the specified thickness of chromium plate in the chamber. Small auxiliary anode attached to fixture (see 6.2.1.4.5) on exterior of barrel for plating gas port, if plating of gas port is specified on the drawing.

6.2.1.4.2 Cathodes for electropolishing. - Anodes used for chromium plating are also used as cathodes for electropolishing.

6.2.1.4.3 Cathode for stripping chromium plate. - Straight, solid steel bar one-quarter inch in diameter, uncoated.

6.2.1.4.4 Fixtures, steel. - Anode centering caps for muzzle and breech, suitably insulated, for centering anodes and cathodes and for applying tension to maintain straightness of the electrodes.

6.2.1.4.5 Fixture, teflon or saran or equal. - Attached to exterior of barrel to hold auxiliary electrode for plating and electropolishing gas port.

6.2.1.4.6 Electrical connections. - For electrically connecting the barrel to anode and cathode circuits.

6.2.1.5 Temperature control instruments. - Automatic temperature recorders for controlling temperatures of electropolishing and chromic acid etching and plating solutions.

6.2.1.6 Ammeters, voltmeters, and rheostats. - For current control on each individual barrel, when a number of barrels are plated at the same time in the same tank.

6.2.1.7 Lifting equipment. - Suitable for transferring the barrels during the process.

6.2.2 Typical procedure for chromium plating the interior surfaces of the barrels. -

6.2.2.1 Solutions. - Generally, the following solutions will be required:

6.2.2.1.1 Chromium plating solution. -

Chromic acid (CrO_3)	34.0 oz./gal.
Sulfate (SO_4)	0.34 oz./gal.

6.2.2.1.2 Etching solution.

Chromic acid (CrO_3)	34.0 oz./gal.
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6.2.2.1.3 Electropolishing solution.

Sulfuric acid (95 percent) 50 percent by
volume (Ortho) Phosphoric acid (75 percent)
50 percent by volume.

6.2.2.1.4 Lead-tin solution. - For coating electrodes with 7 percent tin-lead.

The solution may be prepared by mixing concentrates of lead and tin fluoborates and fluoboric acid or by operating a standard lead solution prepared as follows, with tin anodes, until a 7 percent tin-lead deposit is obtained:

Basic lead carbonate ($2\text{PbCO}_3 \cdot \text{Pb}(\text{OH})_2$)	20.0 oz./gal.
Hydrofluoric acid (HF) 50 percent solution	32.0 oz./gal.
Boric acid (H_3BO_3)	14.0 oz./gal.
Glue	0.025 oz./gal..

6.2.2.1.5 Commercial alkaline cleaning solution. - Suitable for cleaning steel.

6.2.2.1.6 Alkaline stripping solution. - For removing chromium plate. A proprietary stripping solution or a solution containing 8.0 oz./gal. caustic soda (NaOH).

6.2.2.1.7 Water rinses. - Water for rinsing the gun barrels as required after the various process stages shall be clean tap water at room temperature.

6.2.2.1.8 Decoppering solution. - For removing copper deposits for inspection after proof.

Chromic acid (CrO_3)	67.0 oz./gal.
Sulfuric acid (H_2SO_4)	6.7 oz./gal.

6.2.2.2 Outline of typical procedures for cleaning, electropolishing, and chromium plating. -6.2.2.2.1 Cleaning. -

6.2.2.2.1.1 Preservatives. - Remove all traces of preservative oil from interior and exterior surfaces of barrel with a suitable organic solvent.

6.2.2.2.1.2 Rust. - Examine the interior surfaces of the barrel for the presence of rust. With proper preservation prior to plating, no rust should be present on new production barrels. However, if light rust is present, remove by mopping with sulfuric acid solution containing 1 part of sulfuric acid and 15 parts of water by volume. Rinse with clean, cold water. Flush bore and chamber with alkaline cleaning solution. Rinse with clean, cold water. Dry with clean, compressed air.

6.2.2.2.2 Assembling anode. - Assemble the anode and breech and muzzle fixtures to the barrel. Exert care during insertion of the anode to prevent scratching of the bore or rubbing of tin-lead coated surfaces of the anode. A steel tube protected with plastic tape or a plastic tube may be placed over the anode to protect the bore surfaces during insertion of the anode. Assemble auxiliary anode for plating of gas port.

6.2.2.2.3 Electropolishing. -

6.2.2.2.3.1 Position of barrel. - When electropolishing is specified, electropolish the interior surfaces of the barrel to the required dimensions, with the barrel held vertically in the electropolishing solution.

6.2.2.2.3.2 Current density. - Electropolish at an anode current density of 200-210 amperes per square foot and a solution temperature of $105^{\circ} \pm 5^{\circ}\text{F}$. Based on these operating conditions, the rate of metal removal from the interior surfaces of the barrel is approximately 0.001-inch (0.002-inch on diameter) in 25 minutes.

6.2.2.2.3.3 Full depth electropolishing. - When full depth electropolishing is specified (entire enlargement of interior dimensions produced by electropolishing), remove the barrel from the solution about fifteen or twenty minutes before estimated completion of the electropolishing process, rinse thoroughly with water, disassemble anode and fixtures, and scrub the interior surfaces of the barrel with pumice and water. Rinse with water, dry with clean, compressed air and stargage the interior dimensions of the barrel. Assemble anode and fixtures and electropolish for additional period calculated to complete the process after stargaging.

6.2.2.2.3.4 Minimum depth electropolishing. - When the minimum enlargement of the interior dimensions by electropolishing

(0.002-inch deep or 0.004-inch on diameter) is specified, it will not generally be necessary to stargage the interior dimensions after the electropolishing operation unless the barrel has been selected for the determination of chromium plate thickness.

6.2.2.2.3.5 Treatment prior to plating. - If the barrel has been removed from the electropolishing solution for stargaging, it should be given a 30 to 60 second treatment in the electropolishing solution immediately before anodic etching and chromium plating.

6.2.2.2.3.6 Rinsing after electropolishing. - To avoid drag-in of the electropolishing solution into the etching or chromium plating solutions, rinse the barrel and fixtures thoroughly after removal from the electropolishing solution as follows:

Immerse the barrel and fixtures in a cold water (room temperature) rinse tank with running water for five minutes, and at the same time flow water through the bore and chamber with a hose. Raise the barrel from the rinse tank and flush the barrel and fixtures with water from a hose.

6.2.2.2.4 Anodic etching before plating. - Transfer the barrel after rinsing to the anodic etching tank and anodically etch the interior surfaces of the barrel for 3 to 5 minutes at an anode current density of 200 amperes per square foot and a solution temperature of 130°F. (The chromium plating solution can be used for anodic etching, but a separate anodic etching tank is preferable to minimize build up of the iron content of the plating solution.)

6.2.2.2.5 Chromium plating. - Transfer the barrel without rinsing to the chromium plating solution and chromium plate the interior surfaces of the barrel (held vertically in the solution) at a cathode current density of 300 amperes per square foot and a solution temperature of 130°F for the time required to deposit required thickness of chromium plate (for example five to five and one half hours to obtain a chromium plate thickness of 0.006-inch on the tops of the lands.)

6.2.2.2.5.1 Rinsing after chromium plating. - Remove the barrel from the chromium plating tank, allow the plating solution to drain back into the tank, and transfer the barrel to the water rinse tank. Flush the barrel with clean, cold water to remove chromic acid from the surfaces and dry with clean, compressed air.

6.2.2.2.5.2 Unplated surfaces. - Disassemble anode and fixtures from the barrel. Clean any stains from exterior surfaces and coat all unplated surfaces with grease conforming to Specification MIL-G-16173, Grade 2.

6.2.2.2.6 Phosphate coating. - The phosphate coating MIL-C-16232, Type I specified for the exterior of the barrels obviously should not be applied prior to electropolishing and plating, since it will be removed during these operations. In addition, when the chromic acid strip (see solutions) is used to remove copper from the interior surfaces of the barrel for inspection after proof firing, it has been found desirable to proof fire the barrels before the application of the phosphate coating since it is difficult to employ the decoppering solution without damage to the phosphate coating.

Notice. - When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specification, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

APPENDIX

ACCEPTANCE STANDARD FOR

PLATING, CHROMIUM, ELECTRO-DEPOSITED

(ON THE INTERIOR SURFACES OF

20MM MARK 11 GUN BARRELS).

10. SCOPE

10.1 Scope. - This appendix covers acceptance standards for the chromium plate on the bores, grooves, and chambers of 20mm Mark 11 Gun Barrels.

10.2 General. - When inspected prior to firing, after proof firing, and after functional firing in accordance with this specification, the chromium plate on the interior surfaces of 20mm Mk 11 Gun Barrels shall conform to the acceptance criteria specified in 10.3, 10.4, 10.5, and 10.6, respectively.

10.3 Chromium plate on the bore and grooves prior to firing. - After plating and prior to firing, the chromium plate on the bore and grooves of gun barrels shall be judged in accordance with photographic Plates No. 1 through No. 8, and shall be accepted or rejected in accordance with Table I.

TABLE I - Acceptance criteria for the chromium plate on the bore and grooves of 20 MM Mk 11 Gun Barrels prior to firing.

Photo plate	Defect and limitation	Area	
		A ¹	B ²
No. 1	Plated over single chip.	Accept	Accept
No. 2	Thin chromium plate from plated over chip.	Accept	Accept
No. 3	Trees (small).	Reject	Accept
No. 4	Individual nodules (Not more than 3 locations) (over 3 locations).	Reject	Accept
		Reject	Reject
No. 5	Clusters of small pits or nodules 0.005 inch or less in diameter. (Not more than 4 locations) (Over 4 locations)	Reject	Accept
		Reject	Reject
No. 6	Chipped plate.	Reject	Reject
No. 7	Rough nodular condition.	Reject	Reject
No. 8	Clusters of plated over chips.	Reject	Reject

A¹- Origin of rifling to 6 inches forward of origin of rifling.

B²- Six (6) inches forward of origin of rifling to muzzle.

10.4 Chromium plate on the chamber. - Chromium plate on the chamber of gun barrels containing defects similar to the defects shown in photographic Plates No. 9, No. 10, No. 11, and No. 12 shall be rejected except as specified in 10.4.1.

10.4.1 Exception. - Chromium plate on the chamber containing defects similar to those shown in photographic Plate No. 9 may be accepted provided such defects can be polished out without producing pits in the chromium plate such as those shown in photographic plate No. 12.

10.5 After proof firing. - After proof firing (3 rounds) the chromium plate on the bore and grooves of gun barrels shall be judged acceptable if the total length of the bore and grooves does not show more than 4 small chips similar to those shown in photographic Plate No. 14, and not more than 2 medium size chips similar to those shown in photographic Plates No. 15 and No. 16.

10.6 Chromium plate on the bore and grooves of gun barrels after functional firing. -

10.6.1 General. - After functional firing, deformation of the land generally occurs at the forcing cone with subsequent cracking and chipping of the chromium deposit in that area (see Plate No. 13). Chipping of the deposit can be expected scattered throughout the bore and sides of the grooves varying in size from small to medium size chips (see Plates No. 14, No. 15, and No. 16).

10.6.2 Acceptability after functional firing. - The chromium plate on the bore and grooves of 20mm Gun Barrels shall be judged acceptable after functional firing the plated barrel 25 rounds, provided the defects in the chromium plate do not exceed the following:

- a. The condition in the area of the forcing cone does not exceed the defects shown in photographic Plate No. 13.
- b. The chromium plate does not show more than 12 scattered medium size chips similar to those shown in photographic Plates No. 15 and No. 16.
- c. The chromium plate does not show more than 40 scattered small size chips similar to those shown in photographic Plate No. 14.

10.6.3 Additional rounds. - Increasing the number of rounds fired, from 25 rounds to 60 rounds will increase the number of chipped areas (see 10.6.2) by 10 to 20 percent.

Defects in the chromium plate on the bore of 20MM
Gun Barrel Mark 11, prior to firing tests.



PLATE No.1 - Plated over
single chip.



PLATE No.2 - Thin chromium
plate from plated over chip.

Defects in the chromium plate on the bore of 20MM
Gun Barrel Mark 11, prior to firing tests.

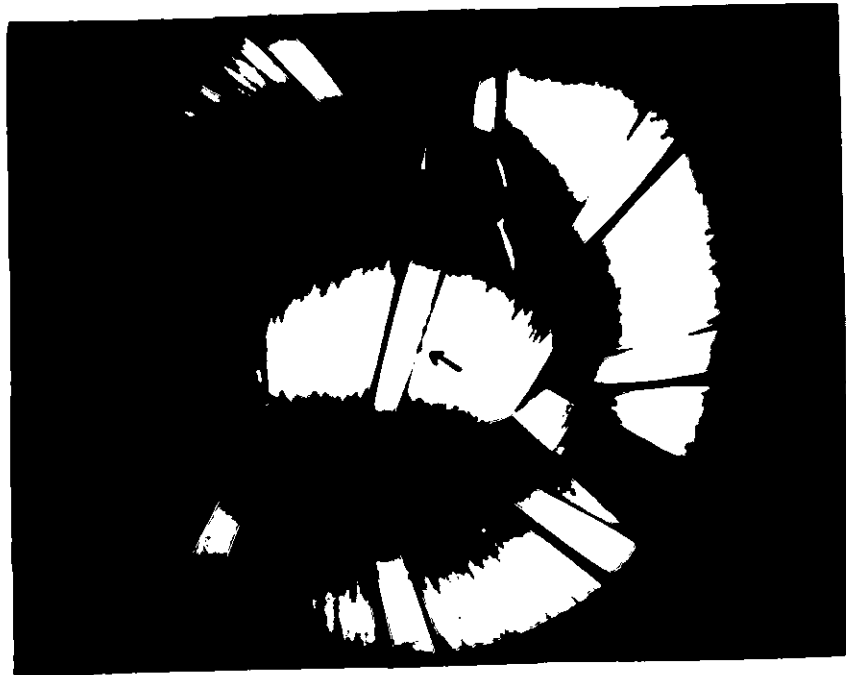


PLATE No.3 - Trees (small)

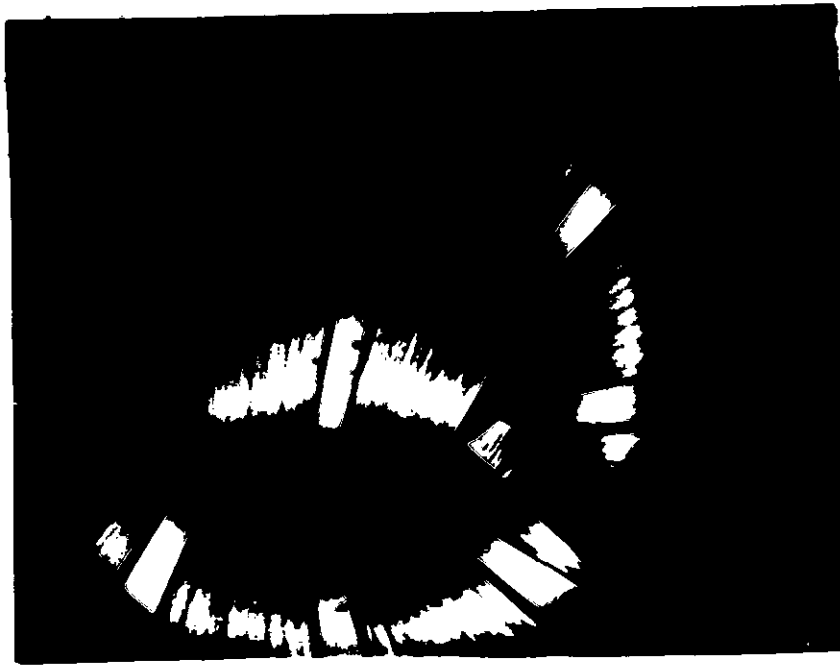


PLATE No.4 - Individual Cracks

Defects in the chromium plate on the bore of 20MM
Gun Barrel Mark 11, prior to firing tests.



PLATE No.5 - Clusters of
small nodules.



PLATE No.6 - Chipped plate.

Defects in the chromium plate on the bore of 20MM
Gun Barrel Mark II, prior to firing tests.



PLATE No. 7 - Rough nodular
condition.



PLATE No. 8 - Clusters of
plate over chips.

Defects in the chromium plate on the chamber of 20MM
Gun Barrel Mark II, prior to firing tests.



PLATE No. 9 - Longitudinal scratch
in the chromium plate. May be corrected by
polishing (see 10.4.1).



PLATE No. 10 - Rough chromium
surface. Impossible to
correct by polishing.

Defects in the chromium plate on the chamber of 20MM
Gun Barrel Mark 11, prior to firing tests.



PLATE N-11 Unplated area
produced by anode strike
during insertion of anode.

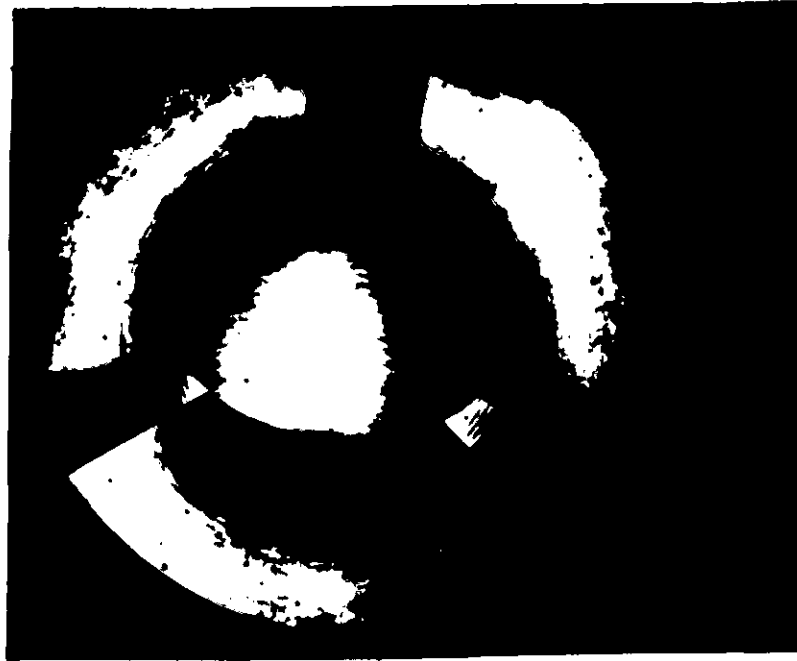


PLATE N-12 - Pitted condition
produced by polishing to remove
nodules.

Defects in chromium plate on the bore of 20MM Gun Barrel Mark 11, after proof and functional firing.



PLATE No.13 - Deformation of the land at forcing cone with cracking and chipping of the chromium deposit.



PLATE No.14 - Small chips at edges of lands.



PLATE No.15



PLATE No.16

PLATES No.15 and No.16 - Examples of medium chipping (extending from edges of lands to not more than one third of the width of the land).

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